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UK CL (Edition K) G4V VPCA VPCB VPCC VPCD VPCX VPD VPEA VPF VPL VPN
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(54) Coin validators

(57) A coin validator (10) comprises a slot (14) which accepts coins of a predetermined diameter and thickness with a small clearance, a guide which receives coins from the slot and a sensor which senses coins moving along the guide. The guide has divergent sidewalls so that a coin (20) of predetermined denomination to be validated will pass close to the sensor whereas coins of smaller diameter or thickness will pass at a greater distance from the sensor. Validation is achieved by the sensor being arranged to sense the distance at which the coin passes. Preferably, the sensor comprises capacitive plates (13, 15, 16) which form a capacitor with the passing coin, and a signal is produced dependent upon the capacitance of the capacitive interconnection which depends on the distance at which the coin passes. The time for which the signal is produced is determined and the validation of the coin depends on this time being within predetermined limits.

FIG.1

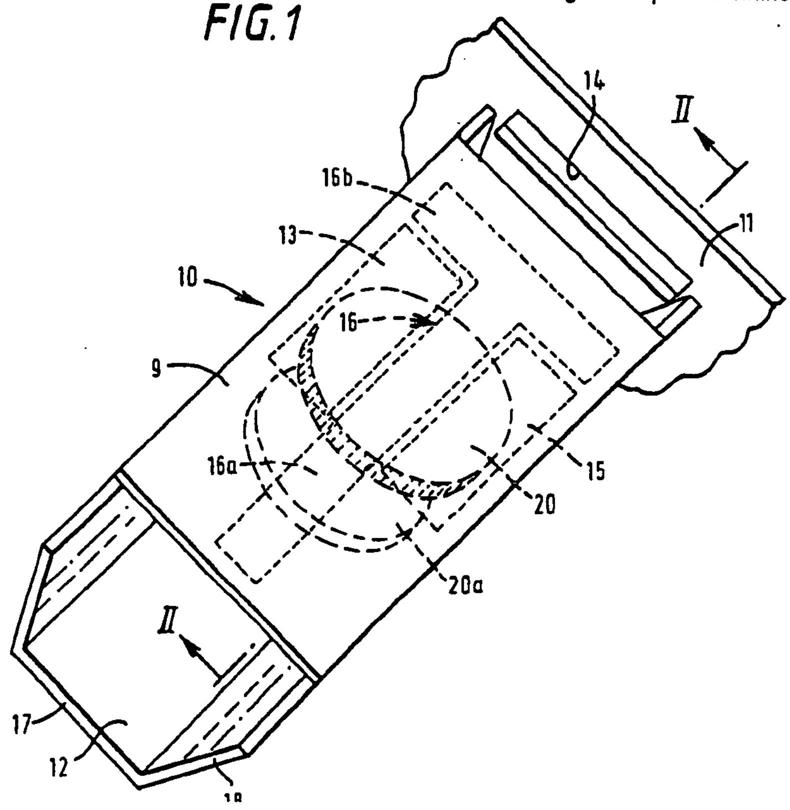


FIG.1

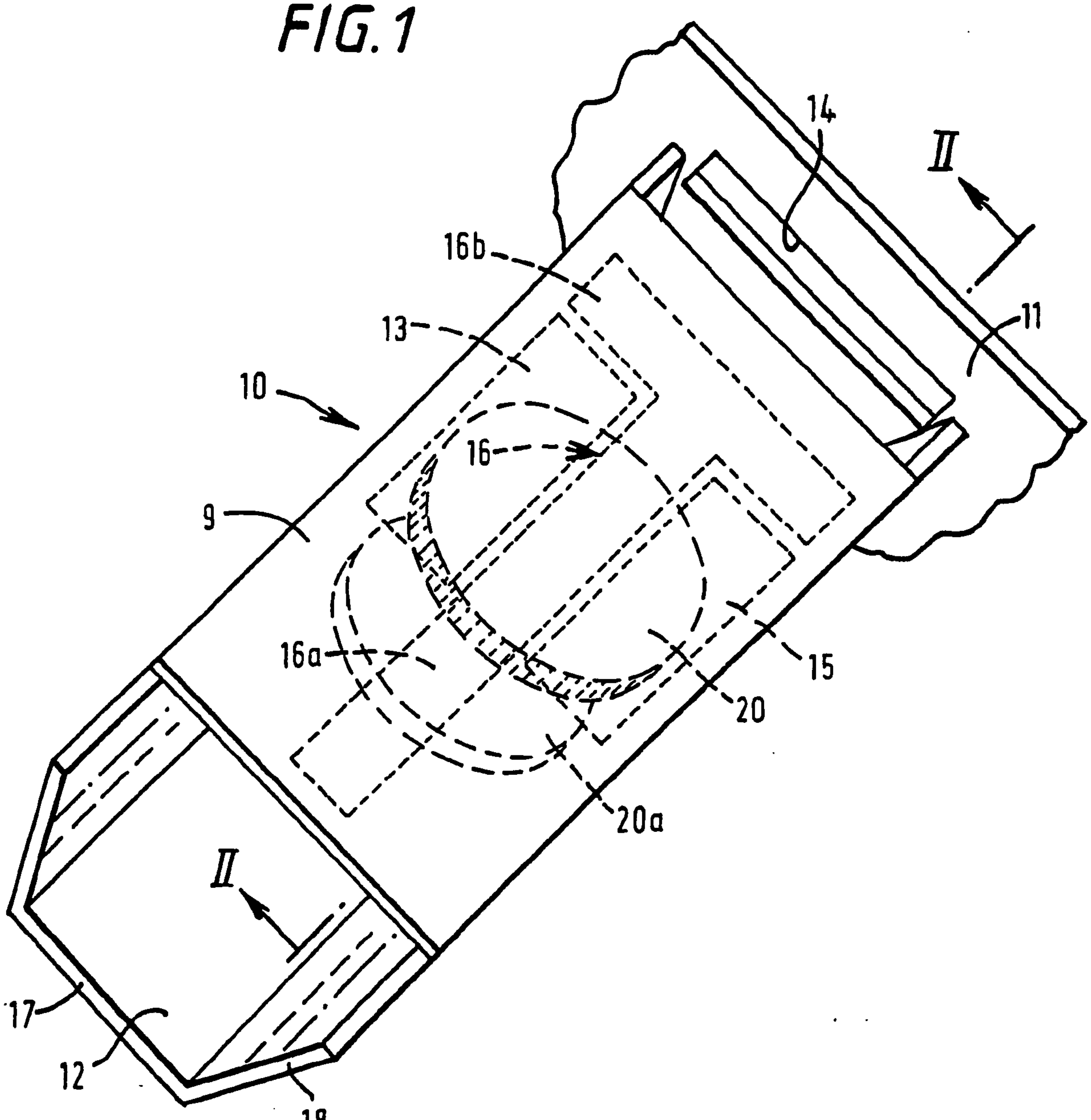


FIG. 2

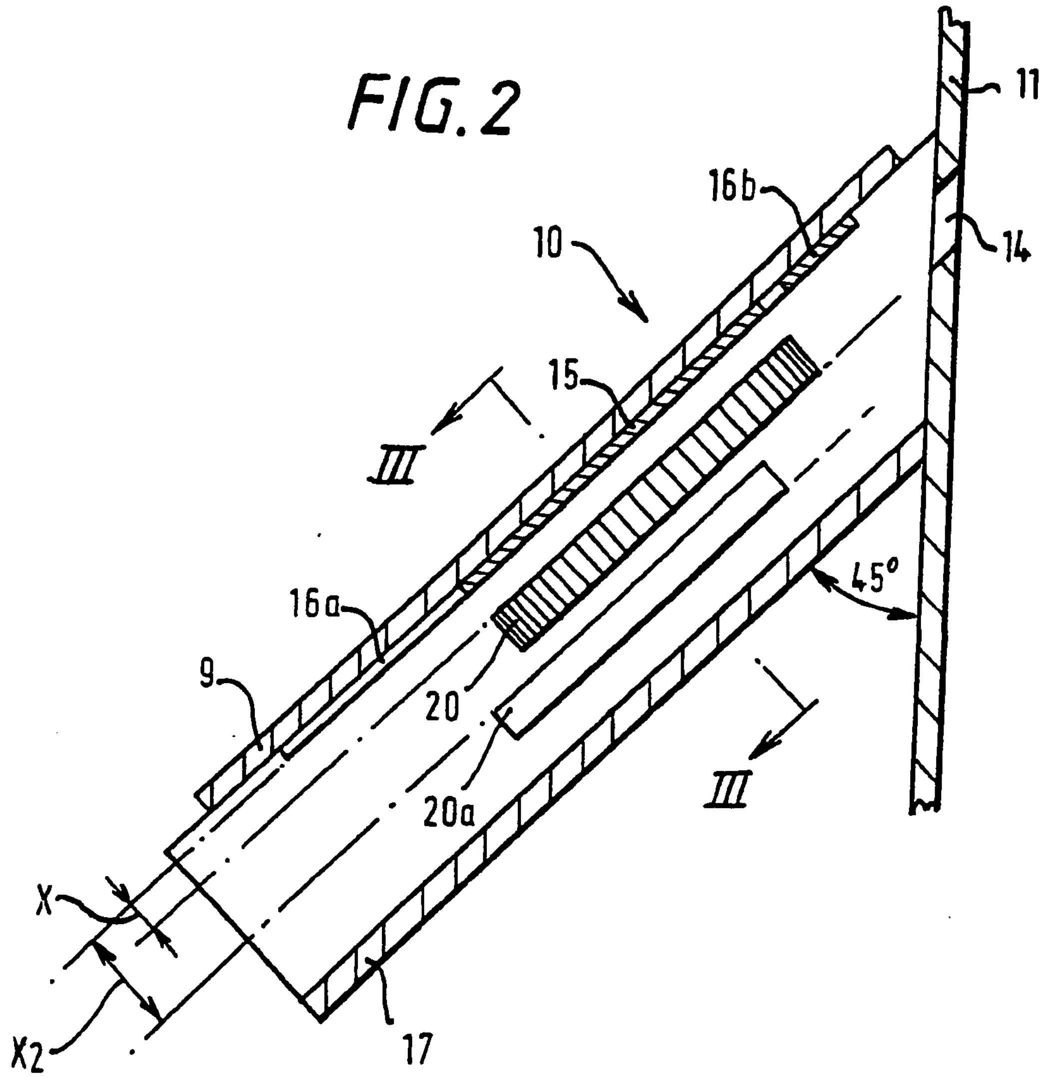

11
16b
14
10
15
III
16a
9
20
45°
20a
III
X
X2
17

FIG. 3

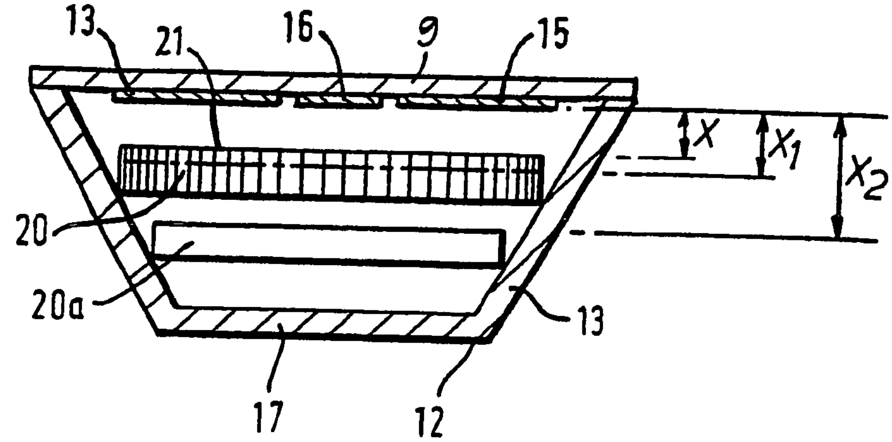

13
21
16
9
15
X
X1
X2
20
20a
13
17
12

FIG.4

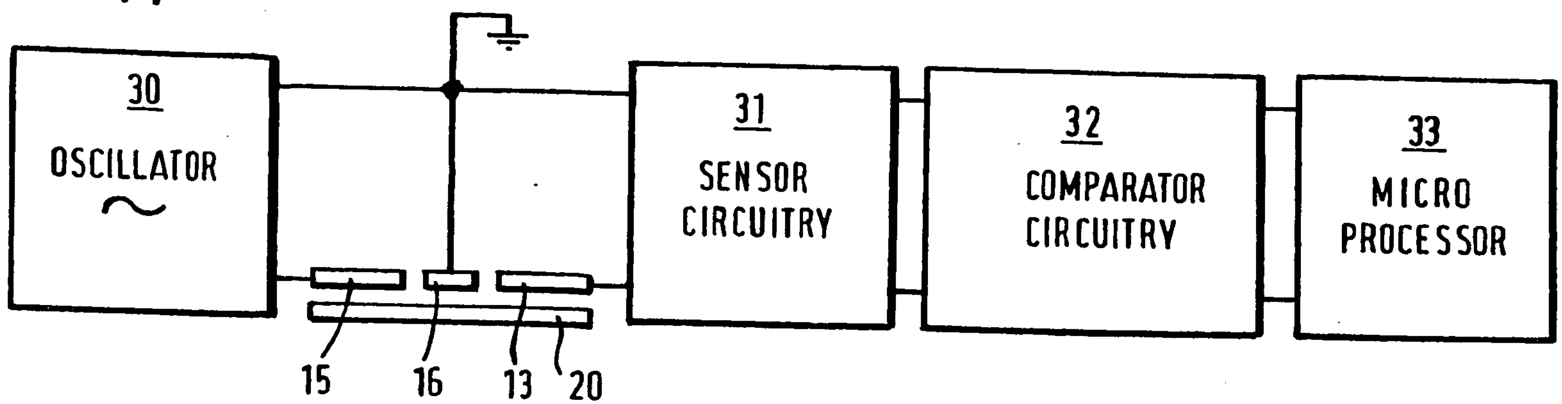

30
OSCILLATOR
31
SENSOR
CIRCUITRY
32
COMPARATOR
CIRCUITRY
33
MICRO
PROCESSOR
15
16
13
20

FIG.5

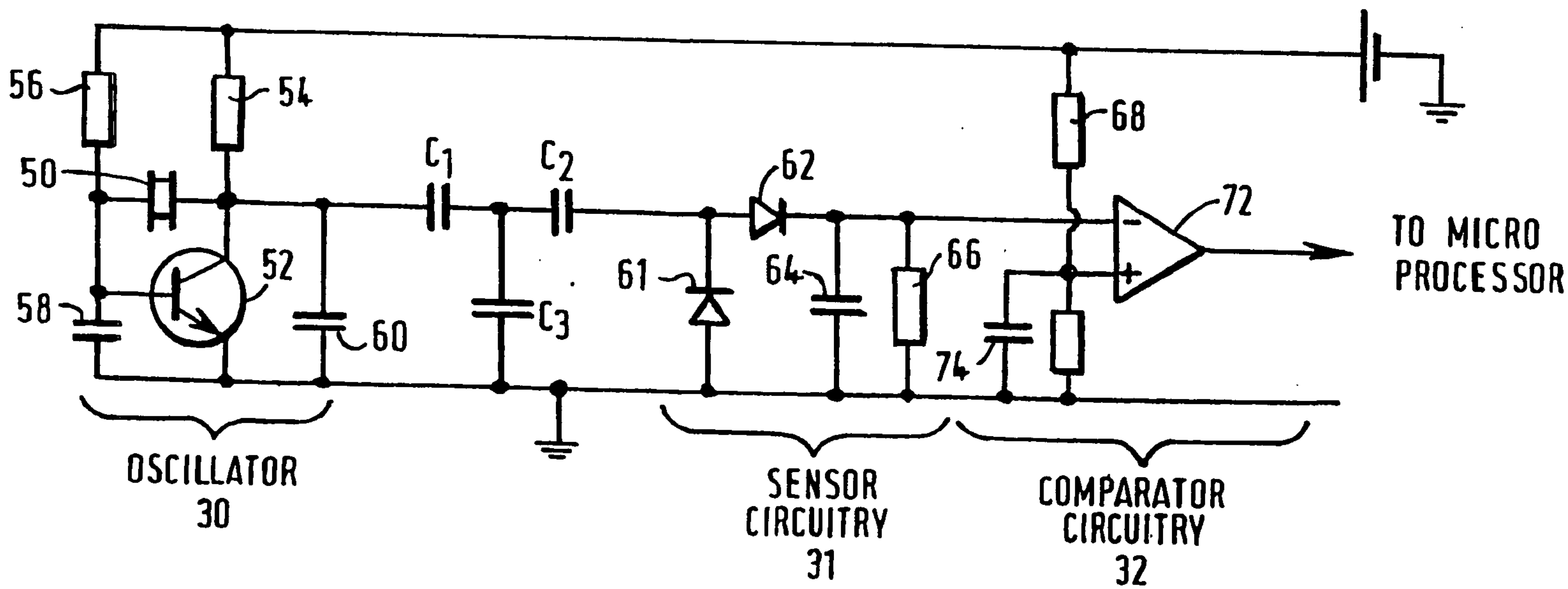

56
54
50
52
58
60
C_1
C_2
C_3
61
62
64
66
68
72
74
TO MICRO
PROCESSOR
OSCILLATOR
30
SENSOR
CIRCUITRY
31
COMPARATOR
CIRCUITRY
32

FIG.6a

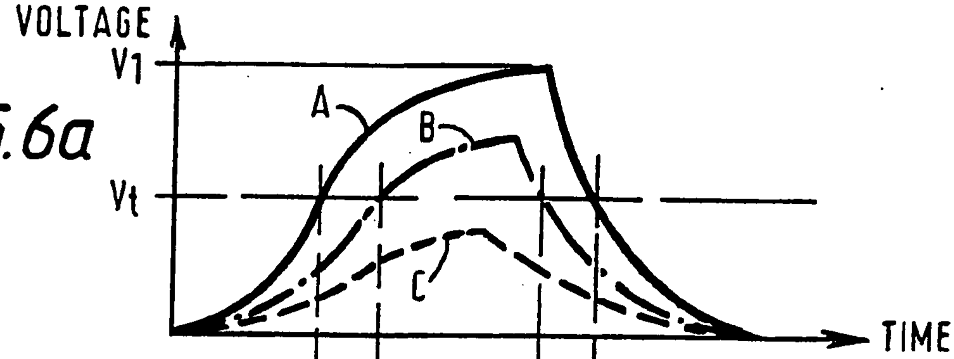


FIG.6b

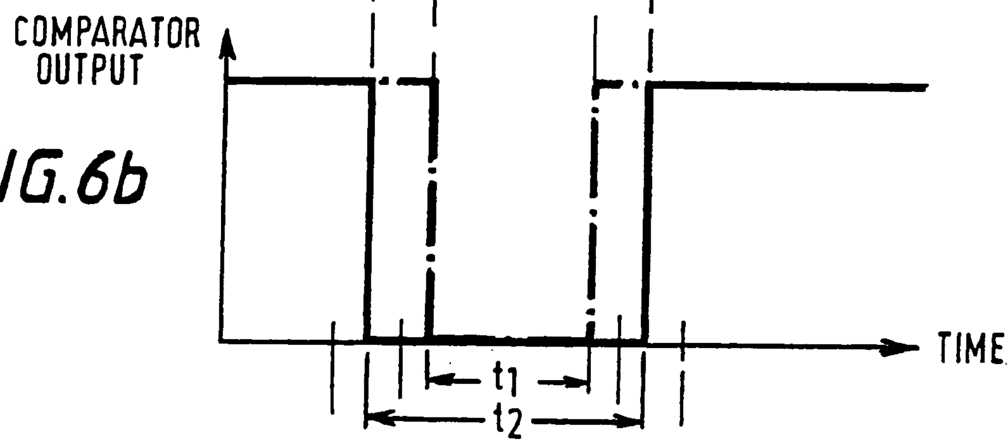
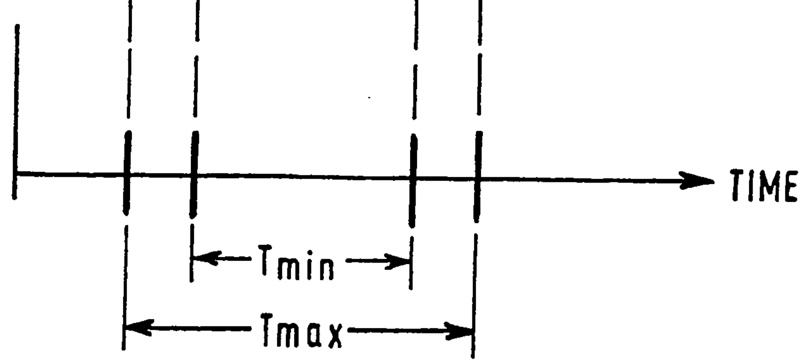


FIG.6c



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COIN VALIDATORS

This invention relates to coin validators.

Many different forms of coin validator are known in the prior art, including those which operate electrically and those which operate mechanically. Mechanical coin validators tend to be expensive and unreliable. Electrical validators, whilst having a relatively high degree of reliability in at least some respects, tend to be expensive.

The object of the invention in one aspect is to provide a relatively simple coin validator which is inexpensive but is nevertheless sufficiently reliable for a variety of uses.

In one aspect, the invention provides a coin validator comprising a guide defining a path along which a coin to be validated may move and a sensor for sensing coins moving along said path, the guide being constructed so that coins of different size will pass the sensor at different distances therefrom and the sensor being operable to sense the distance of the coin therefrom.

In another aspect, the invention provides a coin validator comprising a guide for guiding a coin along a predetermined path and a sensor for sensing coins moving along said path, said sensor comprising first and second conductive members positioned adjacent said path so as to be capacitively linked by a coin passing therealong and circuit means for producing a signal dependent upon said capacitive linking of said conductive members.

As is well known to those skilled in the art, a particular problem which is encountered with coin validators is that a coin of the appropriate denomination to be validated, or a good replica thereof, might be suspended on a string, inserted into the validator to be sensed and validated and then withdrawn. This problem has been difficult to overcome in the prior art. An alternative aspect of the present invention is concerned with providing a solution to this problem. In this particular aspect, the invention provides, in its preferred form, a coin validator which is operable to validate or reject a coin dependent upon the time period for which the coin is sensed. With this arrangement, attempts to defeat the validator by inserting a coin on a string and then withdrawing it are unlikely to succeed provided the

aforesaid time period is set to be within relatively fine limits since it will be difficult for the person inserting the coin on a string to ensure that it is inside the validator and adjacent the sensor for an appropriate time.

The invention is described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view from above of part of a coin validator according to a preferred embodiment of the invention;

Figure 2 is a vertical, longitudinal section along the line 2-2 of Figure 1;

Figure 3 is a cross-section along the line 3-3 of Figure 2;

Figure 4 is an electrical block diagram of circuitry included in the validator of Figures 1 to 3;

Figure 5 is a circuit diagram corresponding to Figure 4;

Figures 6A and 6B indicate signals produced in the circuitry of Figures 4 and 5; and

Figure 6C indicates time periods defined by a micro-processor included in the preferred embodiment.

With reference to Figures 1 to 3, a coin validator 10 comprises a faceplate 11, a channel 12 attached at one end to the faceplate 11 and mounted to extend obliquely downwardly as shown in Figure 2 and a sensor 9 (Figures 2 and 3) in the form of a printed circuit board mounted on the channel 12.

The faceplate 11 is provided with a slot 14 which is in register with the channel 12 and extends transversely thereto. The channel 12 comprises a base 17 and divergent sidewalls 18 and the slot 14 is positioned so that a coin may be inserted therethrough into the channel 12 at a position remote from the base 17 i.e. near to the top of the divergent sidewalls 18. The slot 14 has a width and height such as to permit, with a small clearance, insertion of coins, such as coin 20, of the denomination to be validated whilst blocking insertion of coins of larger diameter or thickness and the spacing and divergence of the

sidewalls 18 of channel 12 is chosen so that coins of this denomination, such as coin 20, will slide down the channel 12 and pass the sensor 9 at a relatively close spacing thereto indicated by dimension X. Whilst coins which are thinner than the coin 20 of predetermined denomination and/or are of smaller diameter than the coin 20, can be inserted into the channel 12 through the slot 14, such coins, such as 20a, will travel down the channel 12 at a much greater distance, such as distance X2, from the sensor 9 than the valid coin 20. The sensor 9 is operable to produce a signal which is dependent upon the distance between the coin and the sensor as the coin travels down the guide and to produce a signal indicating that the coin is valid only when the coin passes sufficiently close to the sensor. Thus, oversized coins will be prevented from being inserted into the validator by the size of the slot 14 and undersized coins will pass the sensor 9 with a distance which is too great to validate the coin.

The sensor 9 comprises first and second rectangular conductive plates 13,15 formed on the undersurface of the printed circuit board so as to face coins travelling down the guide 12. The plates 13,15 are coextensive in the direction of movement of the coin

but spaced apart from each other to leave a gap within which the stem 16a of a T-shaped conductive member 16, also formed on the underside of the printed circuit board, is located. The cross piece 16b of the T-shaped conductive member is positioned between the plates 13,15 and the faceplate 11.

As shown in Figure 4, a high frequency oscillator, for example producing a signal of 3.58 MHz, has its output connected between the plate 15 and the conductive member 16, which is grounded. Sensor circuitry 31 has its input connected between the plate 13 and ground and its output connected to the input of comparator circuitry 32 whose output is, in turn, connected to a microprocessor 33. Since the conductive member 16 is grounded, its stem 16a electrically isolates the plates 13 and 15 from each other and its cross piece 16b electrically isolates the plates 13,15 from electrical influences present at or in the region of the slot 14.

When a valid coin 20 of conductive material passes down the guide 12 close to the plates 13 and 15, the oscillator 30 is connected to the sensor circuit 31 via the capacitance between the plate 15 and the adjacent portion of the coin 20 and the capacitance

between the plate 13 and the adjacent portion of the coin 20. This capacitance gradually increases as the coin moves more and more into registration with the plates 13,15 i.e. as the area of overlap between the plates and the coin increases, and the maximum value that the capacitance reaches when the coin is completely in register with the plates 13 and 15 depends upon the size of the coins and its closeness to the plates 13 and 15. After the coin passes this point as it moves along the guide, the capacitance decreases. Thus, the sensor circuitry 31 senses this capacitance and supplies to the comparator 32 a voltage whose magnitude is dependent upon the capacitance. The comparator 32 is arranged to output a signal to the microprocessor 33 when the voltage exceeds a threshold which is set so that valid coins may be indicated, and the microprocessor 33 responds to this signal to validatate the coin or otherwise.

In Figure 5, the oscillator 30 is shown as comprising a crystal 50, transistor 52, resistors 54 and 56 and capacitors 58 and 60. Capacitors C1 and C2 represent the capacitance between the coin 20 and the plates 15 and 13 respectively and capacitor C3 represents the capacitance between member 16 and the coin. The sensor comprises diodes 60 and 62, a capacitor 64 and

a resistor 66. The arrangement of capacitors C1, C2, C3 and 64 and diodes 60 and 62 is such as to form a voltage doubling circuit. Thus, as a valid coin moves down the guide 12, the voltage on capacitor 64 will rapidly increase. In the absence of a coin, the capacitor 64 discharges through resistor 66.

The comparator 32 comprises a voltage divider made up of resistors 68 and 70 connected to one input of a comparator amplifier 72 and the capacitor 74 connected across the voltage dividing resistor 70. Thus, the amplifier 72 provides an output signal only during periods when the voltage on capacitor 64 is above a threshold defined by the voltage divider 68,70. This threshold is selected so that the voltage across capacitor 64 only exceeds the threshold where the coin which passes the sensor 9 is conductive and is of a coin of the selected denomination to be validated. This is further illustrated with reference to Figures 6A and 6B. Curve A in Figure 6A is a diagrammatic plot of the voltage appearing across capacitor 64 as a valid coin passes down the guide 12. Initially, as the coin begins to overlap the conductive members 13,15, the voltage across capacitor 64 increases at a relatively slow rate. The rate of increase gets greater, however, as the area of overlap increases and

reaches a maximum (i.e. the slope of curve A is at a maximum) at a point where the coin is completely in register with the plates 13,15. As the coin moves past this point, the voltage across capacitor 64 continues to increase but at a slower rate until it reaches a maximum value V1. At this point, the coin has ceased to overlap the plates 13,15 and no more current is thereafter supplied to the capacitor 64. Accordingly, the voltage across the capacitor 64 then decays exponentially.

Figure 6A indicates a threshold voltage Vt set by voltage divider 68,70. As curve A passes through this threshold, the output from comparator 72 drops from a high to a low level as indicated in Figure 6B. As curve A passes back through the threshold Vt during the exponential decay of the voltage on capacitor 64, comparator 72 detects this and its output returns to a high level. Thus, comparator 72 outputs a negative going square pulse whose length is equal to the period of time for which curve A is above the threshold Vt.

Curve B in Figure 6A illustrates the voltage on capacitor 64 produced as a coin or other conductive element passes down the guide 12 at a distance from the plates 15,13 which is too great for the capacitor

64 to be charged up to the threshold level. As a result, the output of the comparator 72 does not change.

If a conductive element which is only slightly smaller or slightly thinner than a coin of the selected denomination passes along the guide 12, the voltage across capacitor 64 may increase to a level greater than the threshold level Vt, as shown by curve C in Figure 6A but at a slower rate than that illustrated by curve A. After this coin or other device has passed the sensor 9, the voltage on capacitor 64 again decays exponentially and at some point will reduce below the threshold level Vt. The result of this will be that the comparator 72 will produce a negative going pulse of shorter duration than that produced by a valid coin. Thus, Figure 6B shows such a shorter pulse of duration t1, the duration of the pulse from the valid coin being indicated as t2.

The micro-processor 33 is programmed to define two time periods Tmin and Tmax which are represented in Fig. 6C and only to validate the coin if the length of the negative going pulse output by the comparator is between Tmin and Tmax. Thus, Figs. 6A, 6B and 6C show that the time period t1 is less than Tmin and

therefore the coin is not validated whereas time period t2 is between Tmin and Tmax and therefore the coin is validated. If the comparator 32 produces a negative going output pulse having a length greater than Tmax, micro-processor 33 will not validate the coin. This ensures that if an attempt is made to defeat the validator by dangling a valid coin on a string and inserting it into the validator, it is unlikely that the coin will be validated because it will be difficult or impossible for the person doing this is to ensure that the period for which the coin is sensed by the sensing arrangement is such as to produce a pulse having a length between Tmin and Tmax.

Accordingly, the preferred embodiment of the invention provides a highly sensitive arrangement for coin validation which is difficult to defeat by dangling a valid coin on a string and which is also difficult to defeat by inserting counterfeit coins because any slight discrepancy between the diameter, thickness or weight of the counterfeit coin compared to a genuine coin is likely to result in either no output pulse being produced by the comparator or, if a pulse is produced, it is unlikely to have a length within the limits Tmin to Tmax. As will be

appreciated, the capacitive sensing arrangement is highly sensative to the thickness of the coin and the distance between the coin and the capacitor plates 13 and 15.

Various modifications are possible within the scope of the invention. For example, although the capacitive sensing arrangement described with reference to the drawings is highly advantageous and economical, other means for sensing the distance of the coin from the sensor i.e. sensing the position of the coin in the guide, could be employed. Further, the capacitive sensor 9 could be employed with forms of guide for the coin other than that illustrated in the drawings. For example, sensing of the diameter of a coin could be performed with this capacitive sensor even where a guide is used which does not cause coins of differing size to move at different distances past the sensor.

Although the drawings illustrate the preferred form of guide, other structures are possible. For example, the guide could be constructed so that coins smaller than the size of coin to be validated pass the sensor at a different angle rather than simply at a different distance or possibly even fall out of the guide altogether before going past the sensor. The guide is

thus arranged in the preferred embodiment so that coins of the correct size will pass the sensor with a predetermined disposition and the sensor senses this disposition.

If desired, a number of coin validators in accordance with the invention can be mounted in a common housing.

It should be understood that the word "coin" as used herein is intended to include tokens of any form.

CLAIMS:

1. A coin validator comprising a guide for guiding coins along a predetermined path and a sensor for sensing coins moving along said path, said guide being constructed so that coins of predetermined size move past said sensor with a predetermined disposition relative to said sensor whereas coins of a different size do not, and said sensor being arranged to sense said coin dependent upon said disposition.

2. A coin validator according to claim 1, wherein the guide is arranged such that a coin moves therealong at a distance from the sensor which depends upon the size of the coin, said sensor being arranged to sense said distance.

3. A coin validator according to claim 2, wherein the sensor is arranged relative to the guide so that smaller coins travel along the guide at a greater distance from the sensor.

4. A coin validator according to any preceding claim, wherein the guide comprises a pair of substantially parallel spaced apart walls which diverge relative to each other as seen in cross-section of the guide.

5. A coin validator according to any preceding claim, wherein the sensor comprises conductive means adapted to form, with a coin moving along said guide, a capacitor whose capacitance varies according to the disposition of the coin relative to the guide, said sensor being adapted to sense the coin dependent upon said capacitance.

6. A coin validator according to claim 5, wherein said sensor comprises an oscillator and a sensing circuit arranged to be connected to the oscillator through said capacitance.

7. A coin validator according to claim 5 or 6, wherein said conductive means comprises first and second conductive plates each adapted to form a capacitor with a respective portion of said coin such that, as the coin passes said sensor, said two capacitors thereby formed are connected in series by the coin.

8. A coin validator according to claim 7, including a further conductive member which is arranged to form an electrical shield between said first and second conductive members.

9. A coin validator according to claim 8, wherein said further conductive member includes a portion positioned to isolate said first and second conductive members from electrical influences adjacent an input end of said guide.

10. A coin validator according to any of claims 5 to 9, wherein said sensor is operable to produce an output pulse of varying length dependent upon said capacitance and including means to validate the coin dependent upon the length of the output pulse.

11. A coin validator according to claim 10, including comparator means whereby said output pulse is produced only if a voltage sensed thereby exceeds a threshold, said sensed voltage being arranged to increase at a rate dependent upon said capacitance.

12. A coin validator according to any preceding claim, including a faceplate having a coin insertion slot dimensioned to accept a coin of said predetermined size with a small clearance, said guide being positioned to receive said coins from said slot.

13. A coin validator comprising a guide for guiding a

coin along a predetermined path, and a sensor positioned adjacent said path, said sensor comprising first and second conductive plates spaced from and electrically isolated from each other but arranged relative to said path so as to be capacitively interconnected by the movement of a coin therealong, and sensing circuitry operable to produce a signal dependent upon the capacitance of said capacitive interconnection.

14. A coin validator comprising a guide along which a coin to be validated may move and coin validating means which is operable to validate or reject a coin dependent upon a predetermined time period within which said coin may be sensed.

15. A coin validator according to Claim 14, wherein said validating means comprises means for sensing a coin located within a predetermined zone and producing a signal indicative of the time for which a coin is within said zone, said coin validating means being operable to accept or reject said coin dependent upon whether the time indicated by said time indicative signal is within predetermined limits.

16. A coin validator according to Claim 15, wherein

said validating means comprises a micro-processor defining said predetermined limits.

17. A coin validator substantially as herein described with reference to the accompanying drawings.